5 Cleanup Standards

MTCA provides the framework for evaluating and selecting cleanup actions, as described in Section 1.1. Within this framework are threshold requirements that must be met by all cleanup actions. The threshold requirements for cleanup actions, as defined in WAC 173-340-360(2)(a), are to:

- Protect human health and the environment
- Comply with cleanup standards
- Comply with applicable state and federal law
- Provide for compliance monitoring

Other MTCA requirements for cleanup actions, as identified in WAC 173-340-360(2)(b), are to use permanent solutions to the maximum extent practicable, to provide for a reasonable restoration time frame, and to consider public concerns raised on the draft cleanup action plan during the public comment period. WAC 173-340-360(2)(c) through (h) identifies additional minimum requirements for cleanup actions. SEPA requires Ecology to consider the adverse environmental impacts of cleanup alternatives and to incorporate mitigation measures to offset these impacts.

The potential for human health and ecological exposures to the IHSs at the site were evaluated in Section 4. This section develops cleanup standards for the site that protects these human health and environmental receptors. This section also identifies the state and federal laws that are applicable to the site and cleanup actions at the site. Adverse environmental impacts and mitigation measures are described in Section 7.

As described in Section 1.1, under MTCA, cleanup standards consist of the following:

- The concentration of a hazardous substance that protects human health and the environment (cleanup level)

- The location on the site where the cleanup level must be attained (point of compliance)

- Other regulatory requirements that apply to a cleanup action because of the type of action and/or the location of the site

Each of these is discussed below. Subsequent sections of this FS/EIS identify and evaluate alternative means of achieving site cleanup.

5.1 Indicator Hazardous Substances

IHSs in addition to TPH were identified through a detailed screening process, as described in Section 3.8 and Appendix D. The IHSs applicable to different media, in addition to TPH, are also summarized in Section 3.8 and include lead, arsenic, and PAHs. Cleanup standards are developed later in this section for comparison to site concentrations, and in many cases the cleanup levels will be the same as the screening levels used to select the IHSs in Appendix D.

5.2 Cleanup Levels

Cleanup levels under MTCA are defined as the concentrations of hazardous substances that are protective of human health and the environment under exposure conditions (e.g., the exposure scenarios developed in Section 4). Cleanup levels are developed for IHSs in media that pose a threat to human and ecological receptors, as summarized in Section 4.4. The relevant IHSs were identified in Section 3.8 and Appendix D for soil, groundwater, sediment, and surface water.

MTCA provides three methods for developing cleanup levels for soil, groundwater and surface water:

1) Method A defines cleanup levels for 25 common site chemicals and is generally designated for routine cleanups

2) Method B determines cleanup levels at sites using a site-specific risk assessment with cancer risk levels established at 10^{-6} for individual carcinogens and 10^{-5} for total site risk, and non-cancer risk at or below a hazard index of 1

3) Method C determines cleanup levels for specific site uses (i.e., industrial) using site-specific risk assessment when Method A and B levels are technically impossible to achieve

Since the cleanup for the site is not considered routine, Method A values will not be used for this site. Method B cleanup levels are applicable to all sites and will be used at this site. Although the railyard is zoned for industrial use, the off-railyard areas are zoned residential, commercial, municipal, and educational; therefore, Method C will not be used for off-railyard areas. Method B will be used to develop cleanup levels for soil at off-railyard areas and for groundwater and surface water for all areas of the site, and Method C will be used for soil at railyard areas.[1]

[1] Method C criteria will be developed for the railyard and incorporated in the Cleanup Action Plan.

MTCA also requires that cleanup levels for each media be at least as stringent as the concentrations established under applicable state and federal law. The applicable state and federal standards for each media will be identified in the following subsections. Figure 5-1 illustrates the general approach to setting Method B cleanup levels at the site.

Sediment cleanup standards are defined under MTCA in WAC 173-340-760, which requires compliance with WAC 173-204 (Sediment Management Standards [SMS]). Under WAC 173-204-520(1)(d), freshwater sediment cleanup screening levels and minimum cleanup levels are determined on a case-by-case basis consistent with the intent of the SMS, which is to "eliminate adverse effects on biological resources and significant health threats to humans" (WAC 173-204-100(2)).

Cleanup levels are set for soil, groundwater, sediment, and surface water. For each of the environmental media, potential exposures to human health and the environment were evaluated in Section 4. Those exposures include the potential migration of IHSs from one media to another. For example, soil cleanup levels must not only protect the people who may come into direct contact with the soil, but also ensure that the ground water cleanup levels are not exceeded. For each of those potential exposure pathways, including the exposure to other media, protective concentrations must be developed (refer to Figure 5-1 for the relationship between cleanup levels in the various media). The cleanup level is the most stringent of those concentrations.

5.2.1 Soil

As summarized in Section 4.4, cleanup levels are developed for human and ecological (terrestrial) receptors in this section. In addition, cleanup levels are developed for soil for two transport mechanisms: soil to groundwater and soil to air. The soil cleanup levels are established in accordance with WAC 173-340-740.

Under Method B, soil cleanup levels must be at least as stringent as each of the following concentrations:

- Concentrations established under applicable state and federal laws
- Concentrations that protect human health
- Concentrations that protect the environment (terrestrial ecological receptors)
- Concentrations that protect ground water quality
- Concentrations that protect air quality

5.2.1.1 Concentrations that Protect Human Health

The establishment of soil cleanup levels that are protective of human health depends on the reasonable maximum exposure expected to occur under both current and future site use conditions. MTCA defines "reasonable maximum exposure" as the highest exposure that can be reasonably expected to occur for a human or other living organisms at a site under current and potential future site use [WAC 173-340-200]. As described in Section 4.4.1, land use across the site varies. The rail yard is currently used as industrial property by BNSF, and the most likely future use of the property is industrial. The highest beneficial use of off rail yard properties is residential. The regulation allows for the establishment of soil cleanup levels based on two types of land use: unrestricted land use and industrial land use. Unless a site qualifies as an industrial property, soil cleanup levels must be based on unrestricted land use. See WAC 173-340-745(1).

At the site, although the rail yard is an industrial land use, the surrounding areas are residential, commercial, and recreational. Consequently, soil cleanup levels will be based on unrestricted land use.

Soil cleanup levels protective of human health were determined using Equations 740-1, 740-2 and 740-3 (WAC 173-340-740) based on a soil direct contact exposure pathway.

Carcinogenic PAHs

Values for the cPAHs that have been identified as IHS for soil were obtained from the CLARC v3.1 (Ecology, 2001a).

Metals

For arsenic, the MTCA Method B cleanup level is the Ecology background concentration of 20 mg/kg. The Method C arsenic cleanup level is 87.5 mg/kg.

The MTCA Method B value for lead will be the cleanup level that is based upon preventing unacceptable blood lead levels and calculated by the IEUBK model (250 mg/kg). The Method C cleanup level for lead is 1,000 mg/kg based on direct contact.

Total Petroleum Hydrocarbons

Finally, Ecology evaluated Method B soil TPH cleanup levels for unrestricted land use in their April 11, 2003 memorandum. The *Worksheet for Calculating Soil Cleanup Level for Direct Contact Pathway: Method B – Unrestricted Land Use (MTCATPH10.xls)* spreadsheet tool provided on Ecology's website was used to perform the calculations required by Equation 740-3 for petroleum mixtures. Petroleum hydrocarbon fractionation data obtained from EPH/VPH analysis of soil samples was used to perform the calculations. A technical memorandum documenting the procedures used for establishing the EPH/VPH dataset is included as Appendix E. See Appendix G for information regarding other site-specific input parameters for the four-phase model.

Iterations of the model were made for each sample to ensure that the back-calculated TPH concentration satisfied four sub-criteria:

1) Hazard index = 1
2) Total cancer risk =1 x 10^{-5}
3) Cancer risk due to benzene = 1 x 10^{-6}
4) Cancer risk due to cPAHs = 1 x 10^{-6}

The median TPH concentration was selected as the cleanup level for a specific soil zone. Cleanup levels developed by Ecology for the vadose and smear zone soil are 2,130 and 2,765 mg/kg TPH (by EPH/VPH method), respectively. Ecology assumed TPH was present at half the detection limit for TPH fractions that were not detected. Ecology also assumed direct contact by a child ingesting 200 mg of soil per day for 6 years, and an acceptable cancer risk of 1 in 100,000.

BNSF believes the assumptions could be modified to develop cleanup levels protective for construction workers, city workers maintaining water lines or other subsurface structures, or residents performing excavation work in their yards. Using these assumptions, soil concentrations well above residual saturation values (i.e., >100,000 mg/kg TPH) are protective for a soil ingestion or direct contact pathway. This calculation is performed by substituting the body weight of an adult for a child (70 kg instead of 16 kg), decreasing the soil ingestion rate from 200 mg/day to 100 mg/day (note this is still twice the soil ingestion rate of an industrial worker) and decreasing the exposure frequency to approximately one-tenth of the year, or 36.5 days per year rather than year-round. This may also be an appropriate methodology for developing TPH remediation levels for soil where a cleanup action that relies, in part, on containment and institutional controls because TPH residual saturation levels protect groundwater, surface water and sediments.

The Method C TPH cleanup level will be developed for Ecology consideration during development of the Cleanup Action Plan.

5.2.1.2 Concentrations that Protect the Environment

The establishment of soil cleanup levels that are protective of the environment requires a terrestrial ecological evaluation (TEE) under certain circumstances. The regulation establishes a tiered process for evaluating potential risks to terrestrial ecological receptors. This process is set forth in WAC 173-340-7490 through 173-340-7494. WAC 173-340-7491 provides for specific exclusions from the TEE requirements. Certain site circumstances provide an exclusion from any further ecological evaluation at a site because the contaminants either have no pathway to harm the plants or animals, e.g., they are under buildings or deep in the ground; or there is no habitat where plants or animals live or forage near the contamination; or finally, the contamination does not occur at concentrations higher than what is found naturally occurring in the area. Ecology has determined that residential areas around the railyard are "contiguous undeveloped property" such that the site does not qualify for an exclusion. See Sec. 4.4.2.5. A site-specific TEE must be performed per WAC 173-340-7493. This evaluation is in process and the results will be available before a Draft Cleanup Action Plan is circulated for further public and agency review and comment.

5.2.1.3 Soil Concentrations that Protect Groundwater

Because hazardous substances in the soil could leach into the ground water, soil cleanup levels must also be protective of ground water quality. To protect ground water quality, soil cleanup levels must be sufficiently stringent to ensure that the potential leaching of residual IHSs from the soil into the ground water will not cause an exceedance of ground water cleanup levels. Section 5.2.2 identifies the ground water cleanup levels for this Site.

As described in Section 4.2.1, the metals IHSs, arsenic and lead, have not impacted groundwater (neither compound is an IHS in groundwater). Therefore, in this section, cleanup levels are only calculated for TPH and its constituents.

WAC 173-340-747 describes various methods for deriving soil concentrations for groundwater protection. Certain methods are tailored for particular types of hazardous substances or sites. Some methods are more complex than others and some require the use of site-specific data. Per WAC 173-340-747(3)(c), the four-phase partitioning model may be used to derive soil concentrations for any site where hazardous substances are present in the soil as a nonaqueous phase liquid (NAPL). Ecology evaluated TPH soil concentrations protective of groundwater, which in turn protects sediments and surface water, using the four-phase model in their technical memorandum dated April 11, 2003 and derived the following cleanup levels:

Basis	Vadose Zone Soil Concentration (mg/kg)	Smear Zone Soil Concentration (mg/kg)
Protection of Potable Groundwater (Hazard Index = 1)	Site-specific residual saturation limit	76.9
Protection of Surface Water to Site-Specific Value of 700 µg/L[2]	Site-specific residual saturation limit	160.3

[2] The derivation of the site-specific surface water criteria of 700 µg/l is discussed in Section 5.2.4.

Therefore, for vadose zone soils, concentrations below site-specific residual saturation limits are protective of underlying groundwater and surface water at the site. Note that the residual saturation limit is the soil TPH concentration, above which free product may accumulate and flow due to gravity. Ecology's default residual saturation is 2,000 mg/kg TPH as diesel or heavy oil. At Skykomish, empirical data indicates that site-specific residual saturation values are in the range of 30,000 mg/kg.

According to the four-phase model results, a smear zone soil concentration of 77 mg/kg TPH is required to protect groundwater and the surface water and sediments into which groundwater flows (selected cleanup level is the more stringent of the calculated values for a particular soil zone). Therefore, a soil cleanup level to protect groundwater would be 77 mg/kg or alternatively, this cleanup standard could be satisfied by attainment of appropriate groundwater criteria (see Section 5.2.2 for derivation of groundwater cleanup levels).

BNSF does not agree that the four-phase model is appropriate for developing soil cleanup levels protective of groundwater at this site. While the model itself is scientifically sound and based on well accepted equilibrium partitioning theory, Ecology's requirement that VPH analytical data serve as the basis for estimating the concentrations of light aromatic fractions (C8-C10 and C10-C12 aromatics) in soil is fundamentally flawed, particularly at Skykomish. The VPH analysis has a high bias for aromatics (i.e., it consistently overestimates the concentration of light aromatics in soil). This phenomenon is acknowledged by Ecology in the VPH analytical method. This bias is compounded several fold in the four-phase model because of the very high solubility limits these fractions possess. As a result, the model predicts that the light aromatic fractions present the greatest risk at this site and that the soil cleanup level must be 2,130 and 2,765 mg/kg TPH for vadose and smear zone soil, respectively, to protect groundwater. The data, however, do not support this conclusion. The light aromatic fractions (C8-C10 and C10-C12) have not been detected above reporting limits (50 µg/L) in any groundwater samples from the site, including groundwater from wells that contain or previously contained free product, and wells near heavily-contaminated soil (>10,000 ppm) in direct contact with the groundwater.

Leaching Tests

As discussed above, WAC 173-340-747 acknowledges that the four-phase model may not be appropriate for all sites and provides various alternatives methods for developing soil concentrations protective of groundwater. WAC 173-340-747(3)(d) states that leaching tests may be used to establish soil concentrations for petroleum hydrocarbons provided sufficient information is available to demonstrate that the leaching tests can accurately predict groundwater impacts. BNSF chose to conduct leaching tests to determine of leaching tests could accurately predict soil TPH concentrations protective of groundwater.

The leaching tests provide site-specific data that conservatively predict the impacts of hydrocarbon- contaminated soil on groundwater. The leaching test results are consistent with the groundwater data and demonstrate that TPH in the soil at the site does not present an unacceptable carcinogenic or non-carcinogenic risk from drinking groundwater, except where free product (defined in MTCA as "a distinct separate layer" of oil) is present. Leaching test results are presented in Appendix F-1.

Leaching Tests vs. the Four-Phase Model

The leaching tests provided site-specific results that predict soil impacts to groundwater more accurately than the four-phase model. For example, the four-phase model calculates a non-carcinogenic risk to groundwater that is dominated by contributions from the C8 -C10 and C10 -C12 aromatic fractions These fractions were not observed above analytical reporting limits (50 µg/L) in the leach testing samples or in groundwater at the site. As noted above, the groundwater samples were obtained from wells that contained free product or historically contained free product or are located near heavily contaminated soil (>10,000 ppm). Similarly, soil used for leach testing contained high concentrations of TPH (>10,000 ppm).

In order to better satisfy the requirements of WAC 173-340-747(3)(d) that "sufficient information is available to demonstrate that the leaching test can accurately predict ground water impacts," BNSF plans to conduct further groundwater analysis at the site The objectives of this ongoing analysis is, in part, to better define the relationship between EPH/VPH concentrations in groundwater. This on-going groundwater analysis will also help explain the presence of aliphatic EC fractions in groundwater well in excess of solubility limits. BNSF believes that free-phase hydrocarbons are causing this phenomenon. This information will be available well before the currently scheduled publication date for public and agency review and comment in May 2004 of the draft CAP.

Table 5-1 lists the soil TPH concentration that BNSF believes is protective of groundwater as "res satr" for residual saturation. BNSF developed these cleanup levels based on the results of the four-phase model, the leaching tests and the soil and groundwater data from the site. Note that TPH is a surrogate for all other organic IHSs because the carcinogenic and non-carcinogenic risk associated with PAHs and benzene are included in the development of this value.

5.2.1.4 Soil Concentrations that Protect Air

Metals

Constituents in soil that could impact air include wind-blown arsenic and lead to outdoor air. Arsenic and lead are identified as IHSs for soil. As discussed in Section 4, a potential exposure pathway that must be addressed is particulate dispersion and subsequent inhalation of these compounds. However, the MTCA Method A cleanup levels shown in Table 5-1 based on direct contact are also protective of this exposure pathway. Therefore, the most stringent soil cleanup levels for lead and arsenic are 250 and 20 mg/kg, respectively.

TPH

Because hazardous substances in the soil could volatilize into the air, soil concentrations must also be protective of air quality. To protect air quality, soil cleanup levels must be sufficiently stringent to ensure that the volatilization of residual hazardous substances in the soil will not cause an exceedance of air cleanup levels. This section evaluates the soil to vapor pathway per WAC 173-340-740(3)(b)(iii)(C) and (3)(c)(iv)(B).

According to WAC 173-340-740(3)(b)(iii)(C), the soil to vapor pathway must be evaluated under the following conditions:

- For gasoline range organics, whenever the TPH concentration is significantly higher than a concentration derived for protection of groundwater for drinking water beneficial use under WAC 173-340-747(6) (four-phase partitioning model) using the default assumptions

- For diesel range organics, whenever the TPH concentration is greater than 10,000 mg/kg

- For other volatile organic compounds, including petroleum components, whenever the concentration is significantly higher than a concentration derived for protection of groundwater from drinking water beneficial use under WAC 173-340-747(4) (fixed parameter three-phase model)

Since soil TPH concentrations exceeding 10,000 mg/kg are present at the site, the second condition listed above is applicable to the site. WAC 173-340-740(3)(c)(iv)(B) states that soil cleanup levels that are protective of indoor and ambient air shall be determined on a site-specific basis. Soil cleanup levels may be evaluated as being protective of air pathways using any of the following methods:

- Measurements of the soil vapor concentrations

- Measurements of ambient air concentrations and/or indoor air vapor concentrations throughout buildings. Such measurements must be representative of current and future site conditions when vapors are likely to enter and accumulate in structures. Measurement of ambient air may be excluded if it can be shown that indoor air is the most protective point of exposure.

- Use of modeling methods. Soil vapor and/or air monitoring may be required to verify calculations and compliance with air cleanup standards.

- Other methods approved by Ecology

BNSF previously performed product headspace analysis and indoor air sampling work at the site that clearly qualify as appropriate evaluation methods per the second and fourth bullets (indoor air sampling and other methods approved by Ecology). Since main septic lines extend from septic tanks to toilets, sinks, etc. in residences, the school and other structures, these lines could serve as a preferential pathway for vapor migration from the subsurface to indoor air. Under these circumstances, an evaluation of indoor air is appropriate, as the potential preferential pathway would lead directly into residences, not to outdoor air. In other words, the most protective point of exposure at the site is indoor air per the second bullet. The indoor air monitoring program coupled with the heated product flux chamber test provides evaluation of "the most protective point of exposure" at the site – and during seven discrete indoor air sampling events.

Indoor Air Sampling

Indoor air sampling (required by Ecology) was completed and evaluated from 1997 to 1999 through a cooperative effort between BNSF, Ecology, the State of Washington and King County Departments of Health, and the Agency for Toxic Substances and Disease Registry (ATSDR). This indoor air sampling program included 6 residences and buildings (including one control) over 7 separate sampling events. BNSF and RETEC believe that the existing primary documents from the indoor air sampling, which summarize the product headspace analysis and indoor air sampling work, more than adequately fulfill MTCA indoor and outdoor air pathway requirements:

1) *Scope of Work and Sampling and Analysis Plan* (SOW and SAP) submitted to Ecology on July 1, 1997, with addendums issued on July 14, 1997 and January 8, 1998. This SOW and SAP, approved by Ecology on July 15, 1997, clearly state the purpose and objectives of the sampling program and were developed over a

period of several months with multi-party involvement including Ecology, the state and county Departments of Health, and ATSDR.

2) *Final Report on Indoor Air Sampling* by ThermoRetec dated April 28, 1999. The indoor air sampling program included seven periodic indoor air sampling events during falling barometric pressure conditions in six residences and public buildings (including one control). The sampling was performed over the period August 1997 to February 1999. As stated in the SOW, comparison of air quality data from indoor air sampling with MTCA Method B cleanup levels for ambient air (WAC 173-340-750) and other screening levels was performed to determine whether vapor evolution from the subsurface to indoor air is a potential exposure pathway of concern at the site. Although the indoor air sampling program was initiated in response to community concern, the SOW was designed and intended to assess the vapor pathway in general.

The results of the extensive indoor air sampling program (seven quarterly events, during falling barometric pressure conditions in public and residential buildings) determined that concentrations of compounds found in the indoor air samples collected in Skykomish are generally typical of indoor air in locations not overlying petroleum plumes. Although background chemical concentrations were detected, many of the compounds were not detected in product headspace samples, so are not associated with migration from the subsurface. Finally, contaminants detected in indoor air were not at concentrations that would result in adverse health effects. Therefore, further evaluation of this exposure pathway is not warranted.

The indoor air sampling described above was performed during falling barometric pressure. This feature of the sampling program was intended to detect any flux of soil vapor from the subsurface into indoor air resulting from a drop in ambient air pressure and subsequent upward movement of soil vapors during equalization of air pressure. This feature of the program addresses specifically the outdoor air pathway as well as the indoor air pathway. Another feature of the indoor air sampling program that makes it particularly well suited to evaluate the outdoor air pathway as well as indoor air is the fact that several of the structures that were sampled have cinder-block, and not continuous concrete, foundations, including the Mackner residence (the site of a single odor complaint by the seller during sale of the home). Cinder block foundations are assumed to be more porous than concrete foundations.

Flux Chamber Evaluation

In addition to the indoor air sampling described above, the SOW included the extreme case of product headspace analysis using a modification of EPA's flux chamber procedure. The product headspace analysis was designed to evaluate, in a worst-case scenario, what constituents could potentially volatilize from petroleum in the subsurface and evolve to indoor or outdoor air. In summary, product samples from various locations of the plume were collected and subjected to a laboratory test similar in concept to EPA's emission flux chamber method. The flux chamber procedure is the same procedure under consideration by Ecology for the proposed ambient air sampling.

For this analysis, a laboratory set-up was used in which the flux chamber was placed directly above the product, rather than on the ground surface in the field. The product was heated to 50 ºC (122 ºF). Note that this is more than double the year-round average groundwater temperature at Skykomish of 51.8 ºF, and therefore an unrealistically conservative estimate of the potential for volatilization of the product. The results of this analysis are presented in the Final Report on Indoor Air Sampling. Comparison of volatile organic compound (VOC) and semi-volatile organic compound (SVOC) analytical results to the Method B standard air cleanup levels for the site in Table 5-2, attached, shows that for most compounds detected in product headspace for which screening levels were proposed, the concentrations are less than the proposed ambient air screening levels.[3] In addition, a TPH air cleanup level of 1,350 µg/m3 was calculated using the four-phase model (MTCATPH.xls), A.4-Worksheet for Calculating Soil Cleanup Level for the Protection of Method B-Air Cleanup Level as presented in Figure 6 of Ecology's February 24, 2003 Memo, *Evaluation of Method B Soil TPH Cleanup Levels for Unrestricted Land Use at BNSF Site* (Ecology, 2003). This value exceeds the cumulative product headspace concentrations (775.12 µg/m3), indicating no potential for adverse risk from indoor air VOCs.

Soil Screening Levels Protective of Air Pathway

USEPA does not recommend using soil concentrations to identify whether or not the vapor intrusion pathway is complete or to model resulting indoor air concentrations, due to uncertainties in the assumptions underlying the standard modeling approach (USEPA, 2002). However, Ecology has proposed a soil cleanup level of 2,900 mg/kg for the protection of indoor air

[3] Naphthalene was detected above MTCA Method B levels in one of three product headspace samples where product was heated to 50^{o}C, however it was also detected in the blank. Indoor air collected from 6 locations during 4 sampling events detected a variety of petroleum constituents, many of which are not found in the petroleum at the site. Naphthalene was measured at concentrations ranging from 0.13 to 0.95 µg/m^3 in indoor air. The MTCA Method B air cleanup level for naphthalene of 1.37 µg/m^3.

quality (Ecology, 2003). Ecology used the four-phase model to develop this soil cleanup level.

Air Pathway Summary

The previous indoor air sampling and product headspace analysis satisfies MTCA's requirement to evaluate the soil to vapor pathway. The data demonstrate that current site conditions and soil concentrations of TPH and its constituents do not pose an indoor or ambient air risk to human health.

Furthermore, Ecology evaluated the soil to vapor pathway in their four-phase model report and determined that this pathway is "not likely to be considered as critical as other exposure pathways" for deriving a Method B soil TPH cleanup level (Ecology, 2003). Ecology calculated a Method B soil TPH cleanup level protective of air quality (2,900 mg/kg), which RETEC believes is overly conservative in light of the empirical data and uncertainties surrounding the model input assumptions. Ecology's proposed cleanup level for soil to protect indoor air is included for reference in Table 5-1.

Nonetheless, it may be necessary to develop air cleanup levels for purposes of protection monitoring construction and operation of the cleanup action, consistent with WAC 173-410(1)(a). For example, if a remedy were selected that would result in an increase in subsurface temperatures, it may be necessary to monitor ambient and/or indoor air, or otherwise evaluate and mitigate any potential increases in volatilization of TPH from the subsurface.

5.2.2 Groundwater

As summarized in Section 4.4, cleanup levels are developed for human receptors in this section. In addition, cleanup levels are developed for two transport mechanisms: groundwater to sediment and groundwater to surface water. The groundwater cleanup levels are established in accordance with WAC 173-340-720.

Under Method B, groundwater cleanup levels must be at least as stringent as each of the following concentrations:

- Concentrations established under applicable state and federal laws
- Concentrations that protect human health
- Concentrations that protect sediment quality
- Concentrations that protect surface water quality

5.2.2.1 Concentrations that Protect Human Health

The establishment of groundwater cleanup levels that are protective of human health depends on the classification of groundwater as either potable (a current or potential source of drinking water) or non-potable. The classification of groundwater depends on the highest beneficial use expected to occur under both current and future site use conditions. Although site groundwater is not considered a source of potable water, the highest beneficial use of water must be protected as a potable source, as groundwater recharges to the Skykomish River and potentially to the former Maloney Creek channel.

Groundwater cleanup levels that protect human health through the groundwater ingestion pathway can be calculated by using MTCA Method B and also by considering drinking water standards established under applicable state and federal laws. These include:

- MCLs established under the Safe Drinking Water Act (SDWA)
- Maximum contaminant level goals (MCLGs) for noncarcinogens established under the SDWA
- Secondary MCLs established under the SDWA
- MCLs established by the state board of health

The MTCA Method B criteria for PAH constituents were obtained from the CLARC v3.1 table (Ecology, 2001a).

Per WAC 173-340-720(4)(b)(iii)(C), Ecology's *Worksheet for Calculating Method B Potable Ground Water Cleanup Levels (MTCATPH10.xls)* was used to perform the calculations required by Equation 720-3 for petroleum mixtures. Ecology performed model runs using the entire EPH/VPH groundwater dataset. Iterations of the model were made to ensure that the back-calculated TPH concentration satisfied four sub-criteria:

5) Hazard index = 1
6) Total cancer risk =1 x 10^{-5}
7) Cancer risk due to benzene = 1 x 10^{-6}
8) Cancer risk due to cPAHs = 1 x 10^{-6}

Ecology derived a TPH cleanup level of 477 µg/L (by EPH/VPH) in groundwater that would be protective of human health.

5.2.2.2 Concentrations that Protect Organisms in Sediment

Because groundwater discharges to the Skykomish River and former Maloney Creek channel, groundwater cleanup levels must also be sufficiently stringent to ensure that groundwater does not cause sediments to exceed cleanup levels established for sediments. Section 5.2.3 identifies the cleanup levels for sediment. Ecology derived a groundwater cleanup level of 64 µg/L TPH to protect aquatic organisms in sediment. This value is based on the results of sediment bioassays and modeling of groundwater to sediment interactions using an equilibrium partitioning approach. BNSF disagrees with the approach used to develop this value since the available bioassay data corresponds to samples with product seeps. BNSF believes that evaluation of this pathway should be performed at a later date, when product seeps are eliminated and representative sediment samples can be collected to assess the impact of dissolved contaminants to benthic organisms. Thus, BNSF proposes a performance based cleanup level for protection of aquatic organisms in sediment. Rather than measuring groundwater in an effort to predict whether these organisms are adversely affected by groundwater, BNSF proposes confirmational monitoring in the form of sediment bioassays following removal of product seeps and impacted sediments. In this case, TPH or confirmational bioassays are used as surrogates for other IHSs.

5.2.2.3 Concentrations that Protect Beneficial Uses of Surface Water

Because groundwater discharges to the Skykomish River and the former Maloney Creek channel, groundwater cleanup levels must also be sufficiently stringent to ensure that groundwater does not cause surface water to exceed cleanup levels established for surface water. As presented in Section 5.2.4, 500 µg/L of TPH (by NWTPH-Dx) is protective of surface water.

The most stringent criteria for groundwater are based on protection of surface water for all IHSs considered (refer to Table 5-1). However, since some of the levels are lower than practical quantitation limits (PQLs), cleanup levels for groundwater and surface water are compared to the PQLs, and the higher of the two values is listed as the cleanup level per WAC 173-340-700(6)(d). All cleanup levels based on PQLs are flagged on Table 5-1. WAC 173-340-707(4) requires that Ecology review cleanup levels based on PQLs every five years and, if necessary and appropriate, Ecology may at that time require the use of improved analytical techniques with lower PQLs.

5.2.3 Sediment

As summarized in Section 4.4, cleanup levels are developed for ecological receptors including fish, shellfish and sediment-dwelling organisms in this section. The IHSs in sediments at the site include lead, PAHs and TPH.

Sediment cleanup standards are defined under MTCA in WAC 173-340-760, which requires compliance with WAC 173-204 (Sediment Management Standards [SMS]). Under WAC 173-204-520(1)(d), freshwater sediment cleanup screening levels and minimum cleanup levels are determined on a case-by-case basis consistent with the intent of the SMS, which is to "eliminate adverse effects on biological resources and significant health threats to humans" (WAC 173-204-100(2)). Sediment quality standards are determined within the range set by the sediment cleanup objective of no adverse effects at the minimum cleanup levels (WAC 173-204(4)).

No chemical specific cleanup criteria have been defined for freshwater sediments (WAC 173-204-520(1)(d)). Procedures for setting cleanup levels in Puget Sound marine sediments using sediment toxicity bioassays are defined in WAC 173-204-570. An approach similar to the procedures defined for marine sediment was applied at this site, using site-specific acute and chronic sediment toxicity bioassays on a suite of three species (Microtox®, *Hyalella azteca*, and *Chironomus tentans*) analogous to the marine sediment procedures. The bioassay results are presented in Appendix B and can be used to define the area of impacted sediments requiring cleanup.

Based on the bioassay results in Appendix B, we propose a minimum sediment cleanup level of 91 mg/kg of TPH, representing the maximum acceptable concentration threshold (MACT) for sediment not impacted by free product. This is the concentration threshold for minor adverse effects to benthic biota.

Ecology is not specifying a sediment cleanup level per se, and Ecology and BNSF are in agreement about the Skykomish River sediment impacted zone. However, Ecology has a different interpretation of the sediment bioassay results, and has derived a sediment TPH value of 23.7 mg/kg for use in back-calculating acceptable groundwater cleanup levels protective of sediment dwelling organisms (see Section 5.2.2.2). BNSF believes this value is overly conservative in that it is below TPH values measured in Skykomish River sediments at upstream, reference stations. Furthermore, this value was derived based on bioassays conducted on sediment samples containing product.

5.2.4 Surface Water

The surface water cleanup levels are established in accordance with WAC 173-340-730.

Under Method B, surface water cleanup levels must be at least as stringent as each of the following concentrations:

- Concentrations established under applicable state and federal laws
- Concentrations that protect human health
- Concentrations that protect the environment (aquatic ecological receptors)

5.2.4.1 Concentrations that Protect Human Health

The establishment of surface water cleanup levels that are protective of human health depends on the reasonable maximum exposure expected to occur under both current and potential future site use conditions. The reasonable maximum exposure for surface water at the site is discussed in Section 4.4 and is based on classification of the Skykomish River as a Class AA River. Therefore, the highest beneficial use of surface water at the site may include water supply, fish and shellfish, wildlife habitat, and recreation.

No IHSs were identified for surface water at the site except for TPH; however, as discussed in Section 4.4, groundwater at the site recharges to surface water. Therefore, it is necessary to establish groundwater cleanup levels protective of surface water, and to consider all groundwater IHSs in doing so. Thus, surface water criteria are developed for the groundwater IHSs in Table 5-1.

Surface water cleanup levels protective of human health are based on ingestion of aquatic organisms and water and are selected from the following:

- National Recommended Water Quality Criteria (2002; NRWQC)
- MTCA Method B surface water criteria for human health protection per WAC 173-340-730(3)(b)(iii)
- MTCA Method B drinking water criteria

MTCA Method B surface water criteria were obtained for all IHSs from CLARC v3.1 (Ecology, 2001a). For petroleum mixtures, Equation 730-1 was used along with bioaccumulation factors for various TPH fractions provided in a technical memorandum prepared by SAIC (SAIC, 2002) for Ecology. These calculations are provided in Appendix H and resulted in an overly conservative value. WAC 173-340-730(3)(b)(iii)(C) allows use of Method A TPH cleanup levels for groundwater as an alternative to this calculation. The MTCA Method A groundwater cleanup level of 500 µg/L of TPH-D or TPH-MO by NWTPH-Dx is included in Table 5-1.

5.2.4.2 Concentrations that Protect the Environment

The requirements and procedures for establishing surface water cleanup levels that are protective of the environment depend on whether environmental effects-based concentrations have been established under applicable state and federal laws. The most stringent concentrations are used for hazardous substances for which environmental effects-based concentrations have been established under applicable state and federal laws. For hazardous substances for which environmental effects-based concentrations have not been established under applicable state and federal laws, a protective concentration must be established. Protective concentrations are defined as concentrations that do not result in adverse effects on the protection and propagation of fish, aquatic life, and wildlife. Whole effluent toxicity (WET) testing may be used to demonstrate that a concentration is protective of fish and aquatic life. In this context, “aquatic life” refers to organisms residing in the water column.

Environmental effects-based concentrations have not been established for the surface and groundwater IHSs at the site. Therefore, WET testing of groundwater obtained from the site was conducted to determine TPH concentrations that are protective of aquatic organisms. WET-testing results are presented in Appendix I. The results concluded that a TPH concentration of 700 µg/L (by NWTPH-Dx) is protective of fresh water organisms. Because the WET-testing measures toxicity associated with all constituents present in groundwater, TPH concentrations are used as a surrogate for all of the IHSs.

The most stringent of the human health and environmental effects-based criteria are selected as the cleanup level for each IHS (Table 5-1). For TPH, the most stringent criteria were human health-based criteria for carcinogenic and non-carcinogenic PAHs, based on fish consumption. However, since some of the levels are lower than PQLs, cleanup levels for surface water are compared to PQLs and the higher of the two values is selected as the cleanup level per WAC 173-340-700(6)(d). All cleanup levels based on PQLs are flagged on Table 5-1.

5.3 Points of Compliance

The points of compliance define the locations where the cleanup levels must be attained. The term includes both standard and conditional points of compliance. Points of compliance are established for each environmental medium in accordance with the requirements and procedures set forth in WAC 173-340-720 through 173-340-760. A conditional point of compliance is only available under certain conditions.

For the site, points of compliance for soil, groundwater, sediments, and surface water must be established and evaluated. The requirements pertinent to the establishment of those points of compliance are summarized below. The standard and conditional points of compliance considered in this FS are also summarized below.

5.3.1 Soil

The point of compliance for soil depends on the exposure pathway that the soil cleanup level is based on.

- **Direct Contact.** For soil cleanup levels based on direct contact, the point of compliance is defined as throughout the site from the ground surface to 15 feet below the ground surface.

- **Soil to Groundwater.** For soil cleanup levels based on protection of ground water, the point of compliance is defined as throughout the site. This means that the point of compliance extends throughout the soil profile and may extend below the water table.

- **Protection of the Environment.** For soil cleanup levels based on protection of the environment, the standard point of compliance is defined as throughout the site from the ground surface to 15 feet below the ground surface. For sites with institutional controls to prevent excavation of deeper soil, a conditional point of compliance may be set at the biologically active soil zone. This zone is assumed to extend to 6 feet. A different depth may be established based on site-specific information. Where a cleanup action involves containment of hazardous substances that exceed cleanup levels at the point of compliance, the cleanup action still complies with cleanup standards, provided the requirements specified in WAC 173-340-740(6)(f) are met.

5.3.2 Groundwater

Below, we discuss the standard point of compliance and the conditional point of compliance.

5.3.2.1 Standard Point of Compliance

The standard point of compliance for ground water is throughout the site, from the uppermost level of the saturated zone, taking into consideration the seasonal groundwater fluctuations, and extending vertically to the lowest-most depth that could potentially be affected by the site (WAC 173-340-720(8)(b)).

For the site, a standard point of compliance is evaluated in Alternative "STD" of this FS/EIS.

5.3.2.2 Conditional Point of Compliance

A conditional point of compliance may also be set for groundwater where it can be demonstrated that it is not practicable to meet the cleanup levels throughout the site within a reasonable restoration timeframe (WAC 173-340-720(8)(c)). Conditional points of compliance may either be set on the property or off the property that is the source of the contamination, subject to several conditions. Off-property points of compliance may be set off property in three specific situations, subject to several conditions specified in WAC 173-340-720(8)(d).

In this FS/EIS, an on-property conditional point of compliance is evaluated in Alternatives PB1 to 5 and an off-property conditional point of compliance is evaluated in Alternatives SW1 to 4. These conditional points of compliance are summarized below.

On-Property Conditional Point of Compliance

The on-property conditional point of compliance must be set as close as practicable to the source of the hazardous substances, but may not exceed the property boundary. The use of an on-property point of compliance is conditioned on the use of all practicable methods of treatment at the site (WAC 173-340-720(8)(c)). Alternatives PB1 to 5 consider an on-property conditional point of compliance. Each of those alternatives sets the point of compliance at the BNSF property boundary (the railyard).

Off-Property Conditional Point of Compliance

The definition of and the requirements for the off-property conditional point of compliance depend on the location of the BNSF property, which is the source of the contamination to the adjacent surface water. In this case, the BNSF property is located near, but does not abut, surface water. Consequently, the off-property conditional point of compliance must be set as close as practicable to the source of the releases that occurred on BNSF's property, but may not exceed the point where groundwater flows into the Skykomish River (WAC 173-340-720(8)(d)]).

The establishment of such an off-property conditional point of compliance is conditioned on meeting several requirements, including, but not limited to the following (WAC 173-340-720(8)(d)(ii)):

- Groundwater discharges must be provided with all known available and reasonable treatment methods before being released into the Skykomish River.
- Groundwater discharges must not result in violations of sediment quality values.
- The affected property owners between BNSF's property boundary and the Skykomish River must agree in writing to setting such a conditional point of compliance.

Alternatives SW1 to 4 consider an off-property point of compliance located at the point of groundwater discharge to the Skykomish River and the former Maloney Creek channel.

5.3.3 Sediment

The point of compliance is the biologically active zone consistent with WAC 173-760 and 173-204. Given that supplemental, site-specific information has not been obtained, the default point of compliance is the top 10 centimeters. Site-specific conditions, such as recontamination potential from subsurface sediments and/or groundwater, must also be considered in determining points of compliance.

5.3.4 Surface Water

The standard point of compliance for surface water is the point at which hazardous substances are released to the surface waters of the state.

At the site, hazardous substances are released to the surface water as a result of groundwater flows. Therefore, the point of compliance must be established at the point at which hazardous substances are released to the surface waters. At the site, this point is where groundwater emanates from the sediment.

5.4 Other Potentially Applicable Requirements

MTCA requires that all cleanup actions comply with applicable state and federal laws (WAC 173-340-360(2)). MTCA defines applicable state and federal laws to include "legally applicable requirements" and "relevant and appropriate requirements." The information is presented in three tables (Table 5-3, Table 5-4, and Table 5-5) categorized as follows:

- Laws pertaining to establishment of cleanup levels
- Laws pertaining to treatment and disposal activities
- Laws that could affect planning or place restrictions on how cleanup actions may be performed.

The laws and regulations cited in this section pertain to non-hazardous wastes only as no "hazardous waste" exists at the site nor is the generation of any hazardous waste anticipated as part of cleanup. Tables 5-3 through 5-5 do not refer to State Dangerous Waste Regulations (WAC 173-304) or Federal Resource Conservation and Recovery Act Subtitle C regulations (40 CFR 260-268) that regulate the management and disposal of "hazardous waste."

6 Development of Remedial Alternatives

This section describes the remedial alternatives that can meet the cleanup standards presented in Section 5. To develop remedial alternatives, individual cleanup technologies were first screened to identify technologies that are implementable and effective at the site. This screening is described in detail in Appendix J and summarized in Section 6.1.

Some of the individual cleanup technologies that are implementable will need further testing to determine their effectiveness at the site. Section 6.2 describes the bench-scale testing that is taking place to determine their effectiveness.

Using the results of the technology screening, technologies that are implementable and effective at the site were grouped into remedial alternatives. Section 6.3 describes the approach that was used to group individual cleanup technologies and develop the resulting remedial alternatives presented in Section 6.4.

In Section 6.4, the remedial alternatives for the site are described. Section 6.4.1 summarizes how each technology (regardless of alternative) would be implemented at the site. Section 6.4.2 summarizes each alternative.

6.1 Technology Screening

This section summarizes the results of the screening process for individual cleanup technologies that should be suitable for cleaning up contaminated soil, groundwater, sediment and surface water at the site. Surface water cleanup was not considered separately in this screening evaluation because cleanup actions designed for sediments, soil and groundwater must also protect surface water. A detailed description of the screening process is presented in Appendix J.

Table 6-1 identifies the cleanup technologies screened and determined to be effective and implementable or to hold promise of being effective and implementable in the context of physical and chemical conditions at the site. In Section 6.4, these technologies are grouped into remedial alternatives that address all of the contamination at the site.

6.2 Bench-Scale Testing of Cleanup Technologies

Few *in situ* cleanup technologies are considered potentially effective for contaminants identified at the site and limited performance data are available